Space Weather Technical Forecast

Issued on Sunday 2 February 2025 at 12:00 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1 Minor Storms Day 1 (02 Feb) with fast solar winds and a potential CME glance. Further M-class flares expected.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate over the last 24 hours with two M-class flares, peaking M3.0 at 02/1012 UTC from AR3981.

There are up to nine active regions on the Earth-facing disc, seven of which are numbered. The majority of the activity is from the cluster of sunspots in the northeast quadrant, consisting of AR3976, AR3977, AR3978 and now AR3981. These form a complex area of multiple bipolar active regions, with signs of magnetic interaction between the regions suggesting the ongoing potential for notable flares. AR3976 and AR3978 have lost their earlier weak delta spots. Meanwhile, AR3981 has developed a small delta region within its intermediate spot portion and shows further rapid growth. The remaining spots groups are small and magnetically simple, with either limited evolution or slow decay.

There have been no Earth directed CMEs (coronal mass ejections) observed in available imagery in the past 24 hours. A fast, asymmetric halo CME emerging in imagery after 02/0530UTC was also associated with a type II radio emission. However, assessment of imagery indicates a far-side source.

Solar Wind / Geomagnetic Activity: Solar winds as measured by ACE at L1, showed the connection to CH11/+, with speeds generally 600-700km/s. Density was below average. The Interplanetary Magnetic Field, Bt, was initially moderate but decreased to weak levels after 01/2100UTC. The north-south component, Bz, was initially moderately variable, between +11/-12nT, but variation steadily reduced to become weak. Phi angle was positive (Away from the Sun). Geomagnetic activity was Unsettled to Active (Kp 3-4).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 was at background levels. High energy electron flux (greater than 2MeV) at GOES16 was at predominantly background levels. The associated 24-hour fluence persisted below the Active threshold, recording 1.32e6 integrated pfu at 02/0000UTC.

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Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Moderate activity is expected, with M-class flares expected at times and a slight chance of isolated X-class flares, primarily from the regions on the northeast disc.

Solar Wind / Geomagnetic Activity: There is one CME in the forecast, which could give a glance on Day 1 (02 Feb). There is uncertainty in the possible geomagnetic response to this - it is most likely to be a glancing blow with little significant effect, but with potential for something stronger. Earth is currently connecting to the fast wind from CH11/+, with speeds around 600km/s at present. Wind speeds are expected to gradually ease during Days 2 and 3 (03-04 Feb), returning to generally slightly elevated levels by Day 4 (05 Feb).

Unsettled to Active geomagnetic activity is expected, with a chance of G1/Minor storms on Day 1 (02 Feb), and a slight chance of a G2/Moderate Storm interval. There is a very slight chance of G3/Strong storms should any CME be more geoeffective. Activity then expected to ease during Days 2-3 (03-04 Feb) to become generally Quiet to Unsettled.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is likely to be at background levels, but with a slightly increasing potential of responding to any notable flares as the sunspot regions in the northeast move towards the western hemisphere. GOES16 high energy electron flux is likely to show a rising trend later in the period, possibly reaching Moderate to High levels by the end of the period. The corresponding 24 hour fluence is expected to persist below the Active threshold Days 1-2 (02-03 Feb), but with an expected rising trend Days 3-4 (04-05 Feb), bringing an increasing chance of reaching the Active threshold by the end of the period

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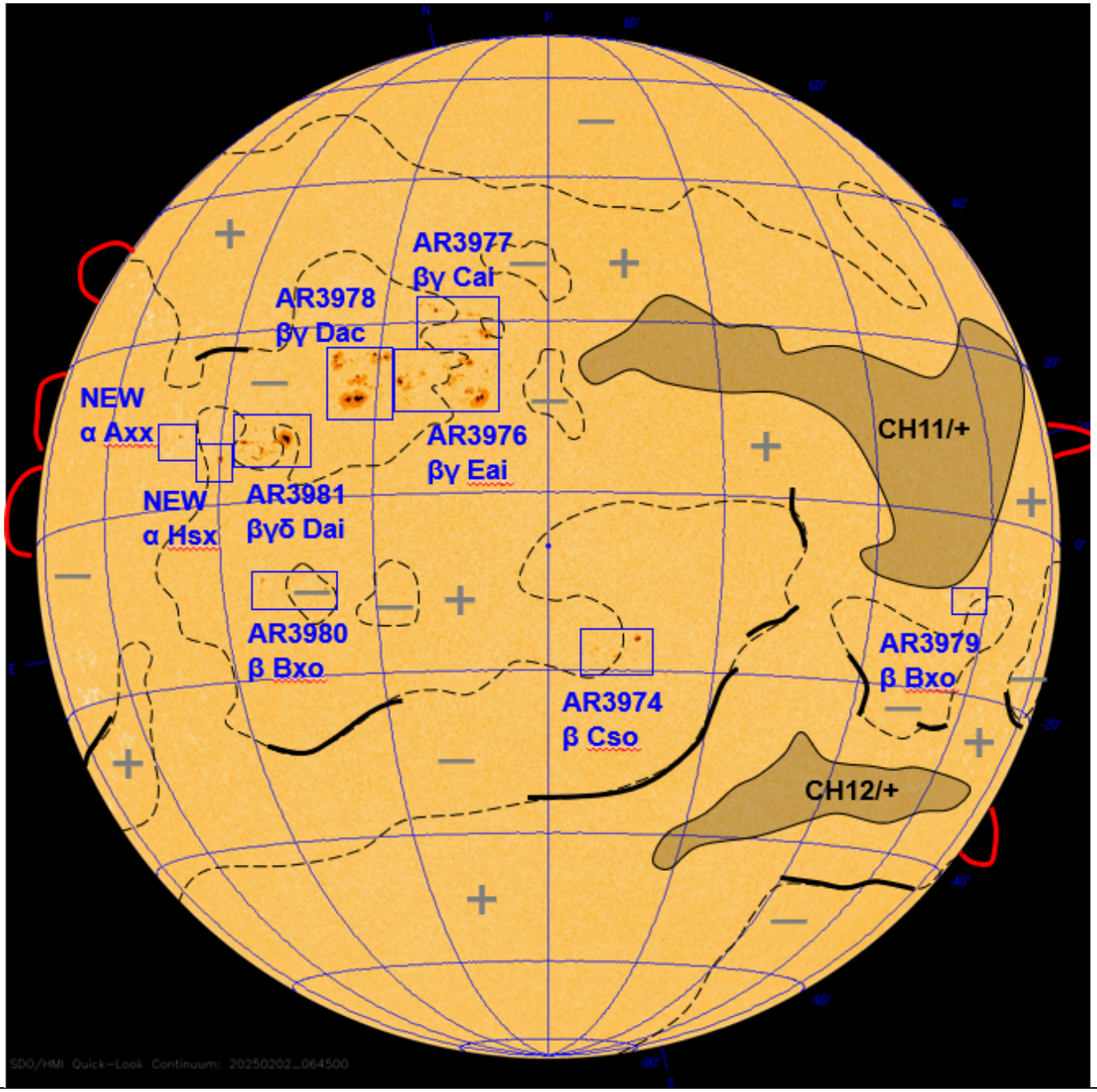
Figure 1: Solar Synoptic Map valid 02/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

One CME currently features in the forecast, however confidence is low. This was from a multi-stage filament eruption off the southeast disc around 30/1400 UTC. This has been modelled as passing mostly behind and south of Earth, however an arrival is possible on Day 1 (02 Feb). There is significant uncertainty in the potential geo-effectiveness of this feature - any arrival would probably be just a glancing blow with little significant effect. However, if we do see some of the main bulk of the CME, it could give a more significant geomagnetic response due to the potential high density from its filament origin. The potential for further CMEs also remains elevated, with a number of large filaments in potentially geoeffective positions and the large cluster of the sunspots in the northeast continuing to rotate across the disc.

Earth is connected to the fast wind from CH11/+ with wind speeds continuing strong, currently around 610km/s. While positive polarity coronal holes are generally less favourable for a strong geomagnetic connections at this time of year, the strength of the wind and the persistence of the feature which brought G1/Minor storms on the last rotation, suggest that this could still be a geoeffective feature. Solar wind speeds are expected to gradually ease during Days 2 and 3 (03-04 Feb), returning to generally slightly elevated levels by Day 4 (05 Feb). This timeframe supported by current MOSWOC ENLIL output, which is providing reasonable guidance at present.

Unsettled to Active geomagnetic activity is expected, with a chance of G1/Minor storms on Day 1 (02 Feb), and a slight chance of a G2/Moderate Storm interval. There is a very slight chance of G3/Strong storms should any CME be more geoeffective. Activity then expected to ease during Days 2-3 (03-04 Feb) to become generally Quiet to Unsettled.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	50	20	5	5
Strong	**G3**	No	10	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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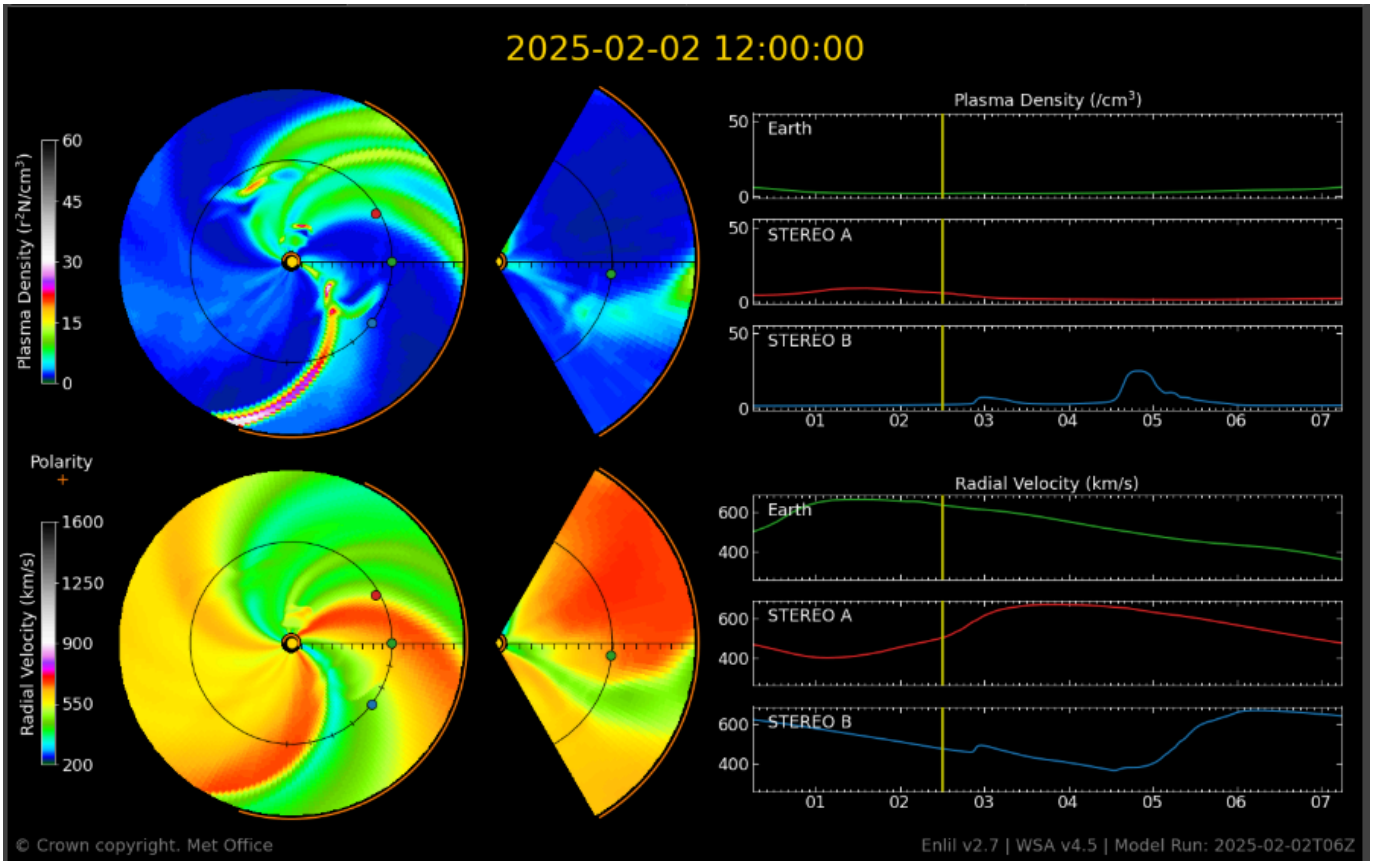
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
30/2345	Partial	Filament	29E 27S	570	02/1200 +/ 10hrs	Low confidence, possible glancing impact.

Figure 2: Latest MOSWOC ENLIL output.



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Radio Blackouts - X-Ray Flares

There are up to nine active regions on the Earth-facing disc, seven of which are numbered. The majority of the activity is from the cluster of sunspots in the northeast quadrant, consisting of AR3976, AR3977, AR3978 and now AR3981. These form a complex area of multiple bipolar active regions, with signs of magnetic interaction between the regions suggesting the ongoing potential for notable flares. AR3976 and AR3978 have lost their earlier weak delta spots. Meanwhile, AR3981 has developed a small delta region within its intermediate spot portion and shows further rapid growth. The remaining spots groups are small and magnetically simple, with either limited evolution or slow decay.

No significant regions are due to rotate off the disc in the forecast period. Recurrence suggests the potential for returning regions during the period, although far-side helioseismic output has no strong signals. Overall further M-class flares are expected, with the risk maintained throughout the period pending further developments. There is a slight chance of an isolated X-class flare from the cluster in the northeast given its overall size and complexity.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	75	75	75	75
Very Active	R3-R5 (X Class)	No	15	15	15	15

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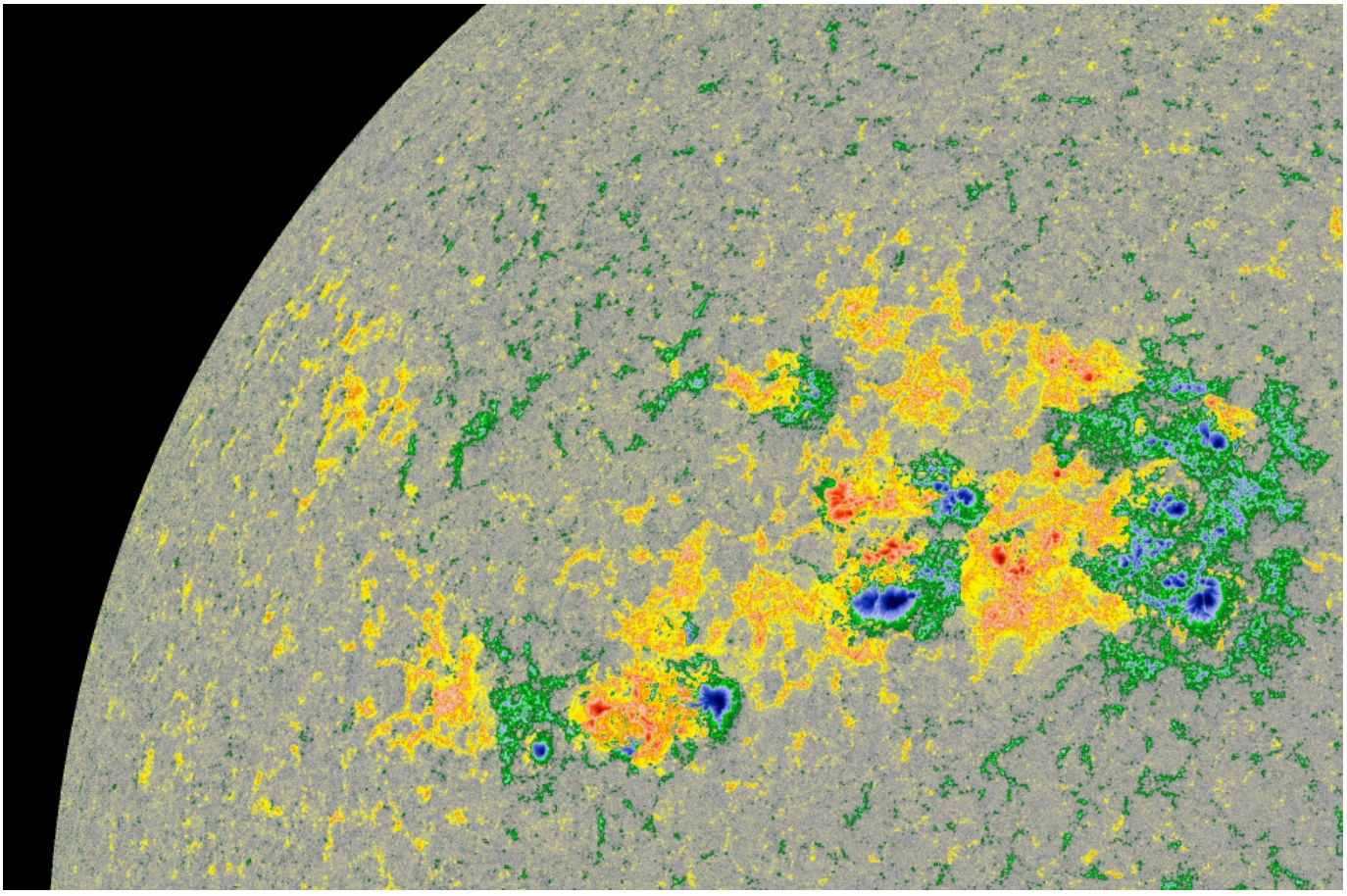
Figure 3: SDO/HMI Magnetogram imagery valid 02/0930UTC, showing the large and complex magnetic structure of the northeast cluster of active regions.



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Solar Radiation Storms (High Energy Protons)

Proton flux as observed by GOES-18 is currently at background levels, and is generally likely to remain that way through this forecast period with the majority of the current solar activity on the northeast disc. As these regions move into the centre-disc, and then into the western hemisphere, there is a gradually increasing chance of proton flux rising in response to any notable flares.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 is currently at largely background levels with ongoing fast winds from CH11/+ likely compressing the Van Allen belts. Geomagnetic activity from the the ongoing HSS, as well as from any potential CME glance on Day 1 (02 Feb), will likely see some increasing charging of the Van Allen belts at lower orbits. As solar wind speed are expected to ease from Days 2-3 (03-04 Feb) onwards, the Van Allen belts should expand back towards GEO, potentially bringing an increase in flux at this orbit. Flux could rise to Moderate levels later in the period, with an increasing chance of reaching High at the diurnal peak.

The corresponding 24 hour fluence is expected to persist below the Active threshold Days 1-2 (02-03 Feb), but with an expected rising trend Days 3-4 (04-05 Feb), bringing an increasing chance of reaching the Active threshold by the end of the period, in the absence of further CME activity. MOSWOC REFM output is currently thought to be providing reasonable guidance, although confidence is reduced due to uncertain CME impacts.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	5	25	50
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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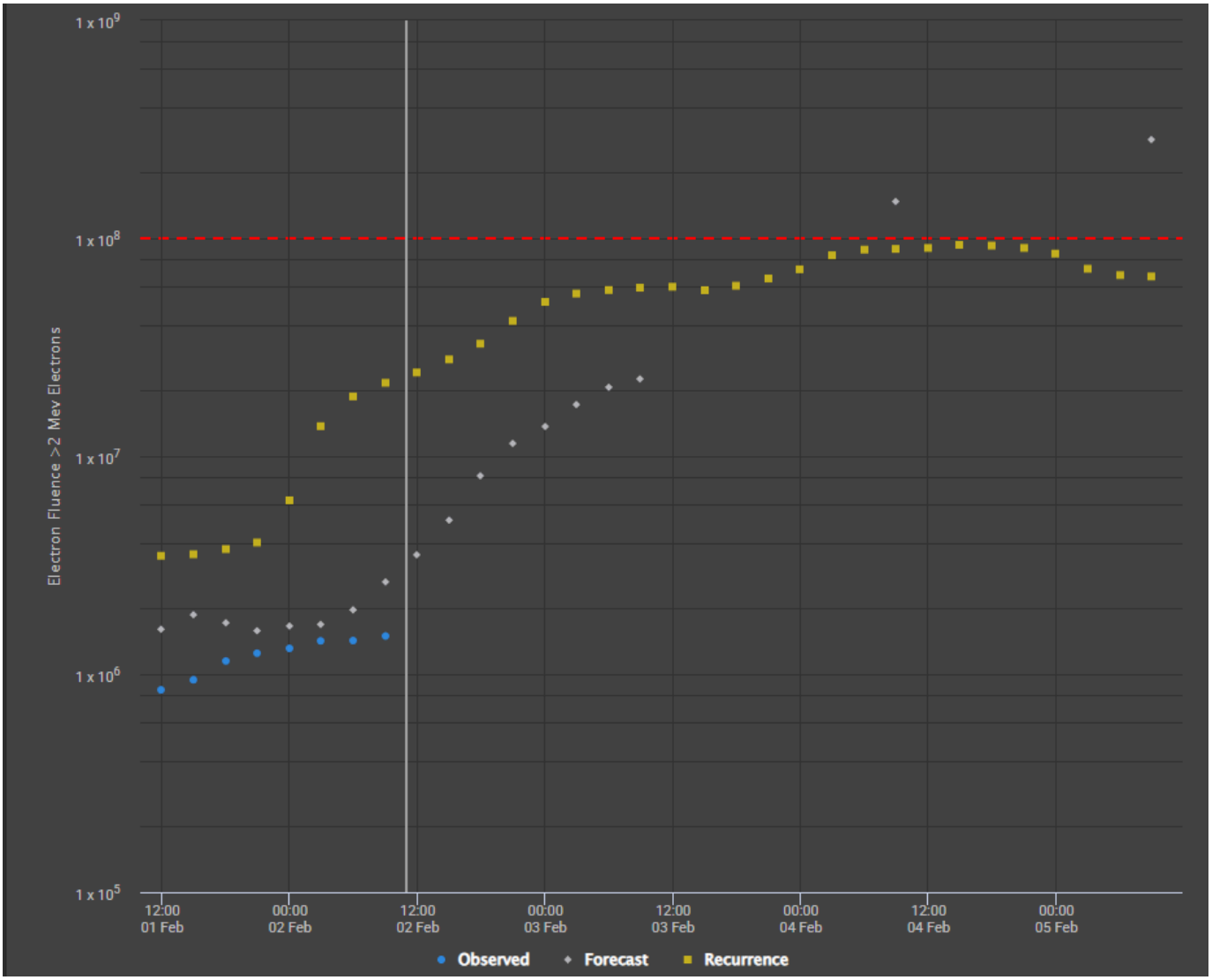
Figure 4: Latest MOSWOC REFM output.



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